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Procedia CIRP 47 (2016) 388 – 393

www.elsevier.com/locate/procedia

Product-Service Systems across Life Cycle

An analysis of buyer-supplier integration for servitization strategies

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Abstract

The Business Model (BM) transformation process, changing from a traditional manufacturing BM to BM focused on servitization (servitized BM), may increase the management complexity, which is also reflected in a need of superior levels of organizational knowledge. Therefore, one alternative to deal with this challenge is by acquiring knowledge from suppliers. However, there is still a lack of studies analyzing the collaboration intensity and knowledge transfer with suppliers to be successful in the BM transformation for servitization. Thus, this paper aims to understand how companies deal with suppliers' knowledge integration aiming for servitization and to understand the knowledge transfer dynamics in this integration. Aiming this, we adapted to the context of servitized solutions development, the framework proposed by Le Dain and Merminod (2014) for supplier integration in collaborative new product development (NPD), which combines three typical supplier involvement configurations (black, grey and white box integration) with the three knowledge sharing levels proposed by Carlile (2004) (transfer, translation and transformation). By means of a multiple-case study analysis of seven multinational companies, we first reinterpreted the three classical supplier integration configuration, showing how they can happen in servitization; then, we analyzed the levels of knowledge sharing that are present in each one of the three suppliers' involvement configurations. Our results show differences of the framework when compared to the original one for supplier involvement. We also discuss causes of such a difference between purely product development and servitized product development.

Peer-review under responsibility of the scientific committee of the 8th Product-Service Systems across Life Cycle

Keywords: Servitization; Knowledge sharing; Supplier integration.

1. Introduction

In past decades, the manufacturing industry used to consider the service offer as an undesirable cost for the business. Today, however, the service offer gained importance also in manufacturers and became a fundamental factor for customers' satisfaction [1,2,3]. This phenomenon was called by Vandermerwe and Rada [4] as servitization, consisting in a business model (BM) innovation of traditional manufacturers – were the traditional product selling focus is changed to a new BM focused on offering a joint solution package of product and services – increasing adding value offered to the consumer [5,3,6].

This BM innovation can be radical or incremental [7], and both may bring important challenges derived from the changes caused in the elements of the traditional BM to become a new Servitized BM [8,9,10]. According to Dahmani et al. [11], the decision-making process during servitization passes through three macro processes: (i) design of a product-service solution, (ii) transformation of a traditional BM to servitized BM and, (iii) organizational change needed to support the new BM.

Several authors point out that some of the principal difficulties for such BM innovation is the gap between the knowledge available in the company (mainly focused only on product) and the knowledge needed to offer a product-service package [10,12,13,14]. This means that companies focused on manufacturing may not have all the required knowledge to become servitized. Therefore, they need to acquire knowledge from outside, i.e, from an external organization or, even, another business unit [2,6].

However, even when prior research has been widely concerned in several aspects of servitization and product-service systems (PSS), only little research can be found regarding how companies involve their suppliers for

Peer-review under responsibility of the scientific committee of the 8th Product-Service Systems across Life Cycle
doi:10.1016/j.procir.2016.03.075

servitization [e.g. 30,32,33] and how they contribute with their knowledge for this new company's servitized BM [2,6,13,16,14,17]. Therefore, our research question is: *how do companies integrate knowledge from their suppliers aiming for servitization*? We address this question mainly from the knowledge management perspective.

Consequently, the aim of this paper is to understand the suppliers' involvement and collaboration during the BM innovation process aiming for servitization, focusing on the knowledge transfer and acquisition strategies during such involvement. Thus, our approach is based on the theory of knowledge sharing during the supplier integration. Aiming this, we used a multiple-case strategy with 7 multinational companies to deeply understand how this phenomenon happens in practice in order to propose a final interpretation of the levels of suppliers' involvement and the kind of knowledge used in each one of these levels.

As result, the main contribution of this paper is that it shows how another field of research, i.e. the supplier-integration in NPD, can support a better comprehension of knowledge sharing dynamic in the context of BM innovation for servitization. Thus, our paper integrates different fields around the topic of BM and servitization.

2. Literature Review

2.1. Knowledge transfer in BMI for servitization

Knowledge is considered one of the most important and strategic resources of an organization [18,19]. Knowledge Transfer (KT) comprises two main actions: the knowledge movement from a source to a recipient and its subsequent absorption and use, taking advantage from previous experience [20,21]. The literature has proposed different perspectives and approaches to describe the KT process [24]. In this paper, we specifically focus on Carlile´s [25] organizational learning theory, since this is the perspective used in the framework proposed by Le Dain and Merminod [26] that will be used for our case study analysis. As observed in Figure 1, Carlile [25] distinguishes three levels of knowledge transfer complexity across boundaries between actors involved in an innovation process: *transfer*, *translation* and *transformation*. Following, we discuss each one of these three levels of KT.

In this first level, *transfer of knowledge*, KT is considered external, explicit and storable. In this case, knowledge can be transferred mainly using information processing tools, e.g. the implementation of a product data management system that allow a common workspace where product data can be shared [25,26]. In practice, knowledge transfer can be identified when occurs an exchange of boundary objects between the actors, e.g., requirement specifications and timelines, prototypes and design drawings, etc. [25,26].

When the level of innovation grows, the complexity of KT increase besides and is needed a transition from a syntactic to a semantic or interpretative boundary because some differences and dependencies became unclear and some meanings ambiguous. This level is called as *knowledge translation*. In this level, the complexity of the knowledge naturally generates interpretative differences and became necessary to use mechanisms to create a shared meaning between actor to cross this new boundary. In practice, knowledge translation can be identified when occurs discussion between the actors to avoid sticky knowledge misunderstanding [25,26,27].

Finally, in a high level of innovation, there is a transition from a semantic to a pragmatic boundary, where a solution has to be found to divergent actor interests. In this process, actors not only have the learning cost of accepting a new knowledge, but they have to transform their existing domain-specific knowledge, and even the common knowledge, to be able to effectively share and assess knowledge at the boundary. This stage is called *knowledge transformation* and is the more complex boundary, because the cost of transforming current knowledge can negatively affect in the willingness of the actor to make the necessary changes. In practice, knowledge transformation activity can be identified when a complex problem solving situation occurs during a project and which result in the building of a new solution [25,26].

As represented in Figure 1 and explained above, Carlile´s [25] framework is composed by 3-T (Transfer, Translation and Transformation) for transferring knowledge across boundaries. These 3-T are related hierarchically and, depending on the level of innovation, the actors will move up and down through the different levels of cross-knowledge complexity. Then, when the innovation level increase, knowledge transfer is necessary for the knowledge translation while the knowledge transformation process requires both transferring and translation, thus, the transfer knowledge process is the basis of the framework. The arrow in Figure 1 indicates that, because of the complexity, managing knowledge across a pragmatic boundary cannot be resolved with just one attempt; it requires multiple iterations [25,26].

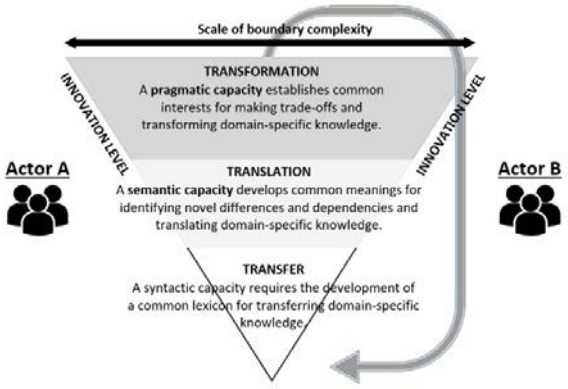

Figure 1: 3-T framework to management of knowledge across boundaries (Source: Adapted from [25])

2.2. The supplier-integration approach

Petersen et al. [28] affirms that the inter-organizational relationship between suppliers and customer during an innovation process can be divided in three configuration levels, according to the supplier involvement: white box (design is customer driven), grey box (joint design) and black box (design is supplier driven). In the *white box* level, the customer is responsible for the whole design and specification of the solution and the supplier is mainly involved in the late project stage, commonly in the execution stage. In the second level of supplier integration, the *grey box* configuration, the design

solution activity is strongly integrated and none of the actors has all the necessary knowledge; therefore, both supplier and customer have the same level of responsibility and importance in the design. Consequently, supplier and customer work in deep collaboration from the beginning of the project until the execution phase. Finally, in the *black box* configuration, the major responsibility has the supplier, who is in charge of both design and execution of the solution, based on customer requirement specification. In this configuration, the customer provides the functional requisites at the beginning of the project and the supplier use its expertise to interact with customer in order to clarify needs and to develop the adequate solution [26,28].

Le Dain and Merminod [26] operationalized Carlile's [25] framework in an inter-organizational stakeholders' context by investigating how this knowledge sharing framework suits for the three configurations of supplier integration in new product development collaboration. Le Dain and Merminod [26] demonstrated that the dynamic of knowledge sharing varies according to the supplier involvement configuration. According to their results, the white box configuration mainly consists of knowledge transfer but this potentially generate knowledge translation to enable process capabilities and requirements to be integrated into the product design. The grey box configuration requires high knowledge transfer, translation and transformation and the dynamic of this process happens cyclically. In black box configuration, a high knowledge transfer is required and substantial knowledge translation during the design phases to clearly define specifications but, different from white box configuration, in this case knowledge transfer requires knowledge translation.

3. Research Method

In order to develop the aforementioned framework, we adopted multiple-case study analysis strategy [29]. Next, we describe the research steps.

3.1 Case selection and unit of analysis

For the case study analysis, we selected cases from seven multinational manufacturing companies, that innovated their BM, changing from a traditional BM perspective to a servitized BM. We intentionally choose companies from different industries and with different relationship with their suppliers, aiming to produce contrasting results that can allow a broader picture of the phenomenon and facilitate the generalization of the results [29]. Table 1 provides a brief description of each case study.

Table 1: Overview of the cases.

Case 1: Company A
a) Company Description: A Swedish multinational (telecommunication industry); with >100,000 employees. ***b) Brief description of Servitization:*** The ICT segment is traditionally the core business of the company, but 15 years ago, the company portfolio was around 30% service and 70% hardware, i.e., a hardware-centric BM. Recently the company portfolio has been inverted to a service-centric BM with almost 70% of service. ***c) Main source:*** semi-structured interviews with a Senior Project Manager from Chile HQ with more than 10 years in the company who has worked in several Latin-American subsidiaries of the company, following closely the company servitization process.

Case 2: Company B
a) Company Description: A Swiss multinational (energy and automation) with >140,000 employees. ***b) Brief description of Servitization:*** Being a company traditionally focused on manufacturing, in this decade has the goal of reaching the proportion of 25% of services in its global portfolio. The company offers maintenance services and performance monitoring, together with the supply of equipment (mainly automation/robotics). However, recently, it has decided also to create a new concept of service consulting for process optimization. ***c) Main source:*** semi-structured interviews with a Senior Project Manager from Spain HQ with more than 12 years in the company, following closely the company servitization process and currently working in improvement process consulting activities.

Case 3: Company C
a) Company Description: A German international company (dental/medical sector), with >1,000 employees. ***b) Brief description of Servitization:*** First, the company tried to sell its main equipment for oral radiographies in the Brazilian market through distributors, the same way that is conducted in Europe and other countries. However, because this market has different characteristic of product usage, Brazilian customers required differentiated services to purchase these products, (e.g. maintenance or immediate replacement, friendly software for printing, online training, training, etc.). ***c) Main source:*** Semi-structured interviews were held with the CEO of the Brazilian subsidiary, who has more than 12 years in the company and was the main responsible for structuring the business in Brazil.

Case 4: Company D
a) Company Description: A US multinational (Process and Motion Control) >7,000 employees and subsidiaries in 49 countries. ***b) Brief description of Servitization:*** Looking for differentiation from its competitors, they offer customized solutions in complex manufacturing process where the cost of failure or downtime is high (e.g. beverage and food processes). ***c) Main source:*** Semi-structured interviews with a supply chain manager of Brazilian HQ, who has more than 15 years in the company and is one of the more experience employees in this subsidiary, with direct relationship whit the service activities.

Case 5: Company E
a) Company Description: A French multinational (energy and automation), with >150,000. ***b) Brief description of Servitization:*** the service structure was created in the late 2010, to satisfy a growing customers demand and, currently, service share are about 20% of company revenue. The company that was traditionally focused in innovation and manufacturing of products, now is offering solutions related to its acting area, that is: Engineering Studies, field services, Projects and Modernization, Efficiency and Sustainability. ***c) Sources:*** As primary sources, semi-structured interviews were held with a Service Manager of the Brazilian subsidiary, who was contracted to develop the service solution.

Case 6: Company F
a) Company Description: Is an US multinational company from IT industry > 100,000 employees. ***b) Brief description of Servitization:*** Since its foundation in the 80s decade, it was a pure hardware vendor, but in 2009 the company entered in the IT service market through acquisition of several companies that were already operating in this segment. The service area today represents approximately 15% of the revenues, and offers several solutions in IT (e.g. applications development, maintenance and modernization services; IT Transformation and Consulting Services). ***c) Main source:*** semi-structured interviews with a Service Sales Manager of the Brazilian subsidiary who is responsible for the services area since the beginning of the service offering in Brazil.

Case 7: Company G
a) Company Description: A Brazilian medium-size company (tailor-made furniture market). ***b) Brief description of Servitization:*** The company traditionally developed and manufactured customized products, but recently, develop a service of long-term plan of "furniture actualization" that consist in modular furniture concept that allows, according to family evolution, a low cost adaptation of the furniture already purchased. This actualization service is designed by the company but executed by outsourced companies. ***c) Main source:*** semi-structured interviews with one of the top managers of the company, and inputs indirectly provided by the other three top managers (i.e. guidelines for strategic planning, definition of competitive priorities, implications from the economic scenario).

Our unit of analysis is the Business Unit (BU). So, we considered as a potential supplier another BU from the same company, but with independent processes, or a different company. To differentiate the BUs from the final consumer, who paid for the product-service package, we will name this last as "client".

3.2 Data collection and analysis

For data collection we used a triangulation approach, using different sources to improve reliability [29]. As a primary source of information we use semi-structured interviews with key employees who participated directly in the servitization process of the company (see Table 1). As a secondary source, we reviewed companies' documents and scientific papers of other case studies made in the same companies.

For data analysis, we used a deductive approach to explore whether the elements identified in Le Dain and Merminod's [26] framework could be recognized in the cases. On the other hand, we used an inductive approach to hypothesize new relevant elements that could be unique for the nature of a servitized model or that were not identified before by the literature. After we analyzed individually each case and identified isolated factors and behaviors, we also performed a cross case analysis to recognize similarities, contrasts and patterns among cases. Finally, the results of the cross-case analysis were contrasted with the literature and a new framework was developed to provide a description of how BM innovation for servitization take place and how knowledge sharing occurs during this process.

4. Results and Discussion

In this section we present each servitization case and analyze how the buyer-supplier configuration affects the knowledge sharing dynamic.

4.1. White Box configuration (design is customer driven)

Dental Services (Company C): As explained in Table 1, Company C had to add services to his main product (dental radiography equipment) to be able to sell it in the Brazilian market. Thus, they added services to adapt the product to a new way of use and for other kind of operators. The product did not suffer any change, but they provided a software service that help to turn the equipment user-friendly for the new applications. After they defined all software specifications, the company established a partnership with a software development company to outsource this development. Several discussions were necessary to achieve a good understanding of the service dimension between the partners.

Computer services (Company F): Traditionally, Company F was a computer selling company, but by the end of the 2000s decade, the company increased its focus in computer services offering. These services are mainly restricted to some standardized services (equipment deployment and IT professional services) which are directly related to the equipment selling. Depending on the geographical location of the client, the services are executed by the company service BU or by an outsourced partner. To be accepted as a service supplier, it is mandatory that technical employees from the partner company attend to a training course to avoid misunderstanding of service specifications and to guarantee the brand quality standards.

Furniture Adaptation Services (Company G): Company G develops a modular furniture concept that allows, according to family needs evolution, the adaptation of the furniture already purchased, with low difficulty and reduced cost. It creates clients' loyalty because they acquire a long time comfort and furniture solution. After Company G sell the first furniture module, the service life adaptation is supplied by partner companies. These partners receive service specification and a few discussions are needed to avoid misunderstandings.

Cross case analysis (Cases C, F and G): The three cases characterize a white box configuration because the service providers were included just in the late project phase, where all specifications were already defined by the manufacturing company. About knowledge sharing, it mainly consists in high knowledge transfer (large specifications), but a moderate to low level of knowledge translating, i.e. moderate level in companies C and F, and low level in company G.

Proposition 1: *White box configuration in servitized BM requires high levels of knowledge transfer and low or moderate level knowledge translation.*

4.2. Grey Box configuration (joint design)

Telecom Services (Company A): The Telecom segment is attended by Company A in two main Business Unit (BU): network infrastructure development (Hardware unit) and Telecom Services (Service unit). The solutions for the client are designed jointly by both BU, i.e., representatives from both BU compound the team that is in direct contact with the client during the design phase. After this phase, the service unit is predominantly in contact with the client. Subsequent to the client´s need identification, there is a jointly discussion between BUs about what product-service package can better satisfy him. However, this discussion has the limitation that there is no possibility to modify the hardware already developed by the company. Then, the solution is restricted to the field of the already existing hardware applications.

Process Optimization Consulting (Company B): Taking advantage from his engineering experience gained in his more than a hundred years of history working with process automation, Company B extended his already existing services of spare parts and maintenance, with a new service of process optimization consulting. This service is executed by an independent service BU, which was formed by some experienced engineers from the manufacturing field. Most services are product-oriented, where the primary objective is to enhance relationship with clients to ensure future manufactured product selling. However, some products are developed directly by demands of the service BU, allowing to provide solution to brand new problems.

Energy Solutions (Company E): Company E was force to develop services to create energy solutions for its clients, since they are gradually changing their needs from buying only energy equipment to buy energy solution aiming to increase the factory capacity. Such solutions cover from the engineering design to the installation of the energy equipment. The service BU is the responsible for the requirements definition with the client and service support, and the engineering BU is responsible to provide advanced technical support, i.e., the knowledge of internal product characteristics, engineering project and the outsourcing of civil constructions, when needed. However, the solutions are not limited to the company´s products; when necessary, the equipment are

acquired from other companies to complete the client solution. Thus, in this complex service projects, the solution is developed jointly between the service unit and the engineering unit, which may generate new knowledge for both sides.

Cross case analysis (Cases A, B and E): Because the solutions are developed jointly between the service and engineering/manufacturing BUs, these cases are configured as Grey Box collaboration. In the three cases we could be observed high level of knowledge transfer, i.e. product and service specifications, documents, e-mails, etc., and also high level of knowledge translation, i.e. very frequent discussions to avoid misunderstanding about what services and product should do. Finally, knowledge transformation could be observed only in Companies B and E, but not in Company A. That is because, while company A BUs were limited to the knowledge of hardware already develop by them to solve client´s problems, companies B and E BUs were open to create innovative solutions that could demand new product development or even external acquisition of products.

Proposition 2: *Grey Box configurations in servitized BM require high level of knowledge transfer and translation. However, knowledge transformation is mainly identified in companies that are not limited to the existing product, but are open to develop a completely new solution (product & service).*

4.3. Black Box configuration (design is supplier driven)

TV and Media Services (Company A): TV and Media is one of the targeted growth areas, which is adjacent to the Telecom core business of Company A. Because of the lack of experience in this area, the company took a different strategy to offer the service to clients: acquisition of companies with experience in offering TV and media services, which became the responsible for the service delivery in an independent way, as an independent service BU. Company A determined strategically only the main characteristics of the service that should be offered and complete design and offering is executed by the independent service BU. Before the service definition, Company A performs several meeting with the acquired companies to discuss how the hardware base, already existing in this company, could be better used in the solution.

Process and Motion Solutions (Company D): Company D´s manufacturing BU develop standardized product that can be assembled in different forms to create customized solutions by the service BU, so-called application engineering. After the definition of the products, the service unit is almost exclusively responsible for the solution development and application. The BUs mostly interchange products specification, but also perform some meetings to assure service BU to understand correctly the limitations of the products utilized in the solutions.

IT Services (Company F): The company F´s IT service division is an independent BU that started with the acquisition of a company already well stablished in the IT service market, mainly focused in providing IT services for industries like health care, government, banking, etc. In this case, the service is developed independently by this unit, only following strategical specifications instituted by the core company. Company F´s hardware is used to operationalize the services. Therefore, this company has predominantly an exchange of hardware specifications and some discussions to avoid specifications misunderstanding.

Cross case analysis (Cases A, D and F): The three cases can be characterized as a Black Box configuration because the design, develop and execution of the services are performed by the service BU. The manufacturing BU only makes some strategical specification for services and offer hardware/product support. Regarding the knowledge sharing dynamic, it can be observed a high transfer between actors in all the cases, mainly of product and service specification, but different levels of knowledge translation. Companies D and F had shown low knowledge translation because the product are standardized and the complexity is only in the service. On the other hand, Company A demands moderate knowledge translation because of the high dependence of the service in the hardware.

Proposition 3*: Black box configurations for servitized BM require high knowledge transfer and low to moderate level of knowledge translation during the definition of the product-service package.*

5. Discussion and Conclusion

Only recently, some authors started to study the buyer-supplier relationship for the development of a servitization strategy. For instance, Bastl et al. [30] and Saccani et al. [33] used Cannon and Perrault´s [31] relationship connectors framework to analyze the behaviors in a buyer–seller interaction in case studies from servitized companies. Even when one of the five connectors of this framework is ‘information exchange’, these authors did not analyze profoundly the different levels of knowledge sharing. Parallel, Paiola et al. [32] developed a framework that suggest four distinct strategic approaches relating the service components and the development of capabilities. Since Le Dain and Merminod [26] conceptual framework was specifically designed to analyze the knowledge sharing dynamic across inter-organizational boundaries, we choose it to study this aspect in the servitization context. Particularly, our findings are complementary to Saccani et al. [33] study, since they found that the information exchange in the service delivery outsourcing is directly influenced by the type of service outsourced, and we found that the knowledge sharing during PSS development is also dependent from the outsourcing strategy, i.e. black, grey or white box.

As we have shown in our findings, the understanding of KS dynamic in buyer-supplier collaboration from servitization can be expanded by bridging two different streams of research: (i) the BMI stream, and (ii) the NPD stream concerned with customer-supplier integration/collaboration. We showed that by integrating both research lines it is possible to obtain a more fine-grained description about the KS among the involved actors, i.e. different servitization strategies demands different configurations and levels of knowledge sharing. Our findings show that in White Box configuration knowledge translation seems to be more important for BMI aiming servitization than in NPD. This is because a service design is more ambiguous than tangible goods, demanding more discussion to avoid misunderstanding. However, in this White Box the KS

dynamic presents a similar pattern to NPD, where first the manufacturing company provides the product and service specifications (knowledge transfer) and then, on top of it, knowledge translation occurs. Something similar happens in Black Box KS dynamic, were in a general sense there is a similar behavior in BMI for servitization when compared with NPD collaboration according to Le Dain and Merminod's (2014) results. Still, for Grey Box configuration, while Le Dain and Merminod (2014) observed that the NPD process requires high levels of all the three types of knowledge and a cyclical dynamic between them emerges, our findings show that this behavior is not a rule in BMI for servitization, and depends on the company´s servitization strategy.

This study has several theoretical and practical implications. As management contribution, it illustrates how companies can take different strategies to overcome the lack of knowledge barrier to become servitized. This can be done by working collaboratively whit other companies or BUs in different types of configurations. At the same time, according with the servitization strategy adopted, our study allows understanding how knowledge sharing occurs during collaborative servitization, which can be a driver for new implementers.

As a theoretical contribution, this paper shows how another field of research, i.e. the supplier-integration in new product development can support a better comprehension of the role of BM innovation for servitization. Thus, our paper integrated different fields around the topic of BM innovation.

Finally, as limitations of this work can be mentioned the fact of using only nine case studies from seven companies, which does not allow the results generalization the results. Therefore, future works can assess this issue through a broader approach, e.g. a survey. Yet, the analysis of how knowledge sharing configuration within each buyer-supplier configuration could be influenced by the core company strategy and business model focus, was not assessed.

Acknowledgments

The authors thank CNPq for the financial support received (Project CNPq Universal Notice No.473659/2013-1).

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